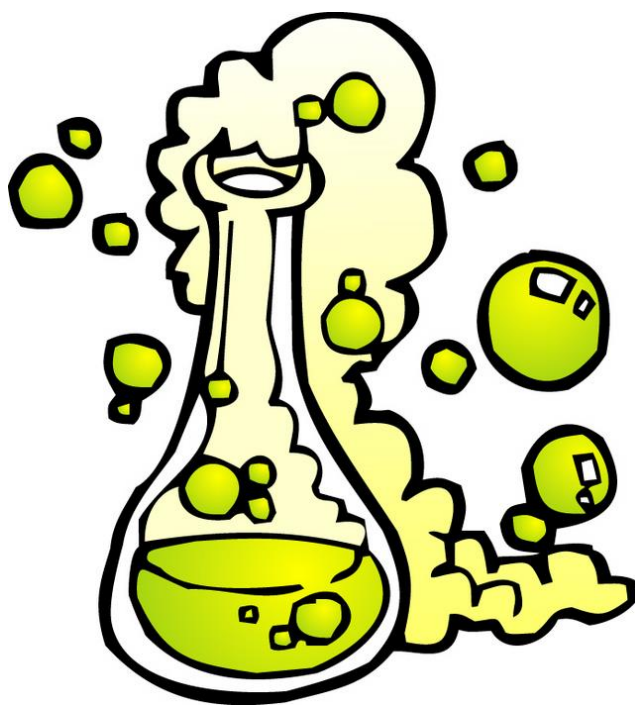


Science 1.8 AS 90947 Investigate selected chemical reactions

WORKBOOK



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1. Changing words into formula
2. Names to formula
3. Combination word and symbol equations
4. Thermal decomposition word and symbol equations
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7. Precipitation word and symbol equations
8. What reaction is that?
9. Justifying your choice of reaction
10. Guidelines for discussion
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Changing compound words into formulas – Visual balancing

Success Criteria: complete each level before moving onto the next

- Basic: write ion formula for the following named ion compounds
- Proficient: write the number of each ion required to balance the charges
- Advanced: balance the ion compounds to create a neutral compound

Cation		Anion	
1+	2+	2-	1-
H Hydrogen	Mg Magnesium	O Oxide	Cl Chloride
Na Sodium	Ca Calcium	SO₄ Sulfate	OH Hydroxide
K Potassium	Cu Copper	CO₃ Carbonate	NO₃ Nitrate
NH₄ Ammonium		HCO₃ Hydrogen Carbonate	

Cation		Anion	
1+	2+	3+	1-
H Hydrogen	Fe Iron (II)	Al Aluminium	Cl Chloride
Ag Silver	Zn Zinc		OH Hydroxide
K Potassium	Pb Lead	Fe Iron (III)	NO₃ Nitrate
NH₄ Ammonium		HCO₃ Hydrogen Carbonate	

Example

Name of compound	calcium	hydroxide
Formula of ions	Ca^{2+}	OH^-
Number of each ion required to balance charges	1	2
Formula of compound	$\text{Ca}(\text{OH})_2$	

Remember:

+ charge means electrons are missing from the ion compared to when they were atoms, the number by the + tells us how many electrons are missing. Each missing electron is a space.

- charge means electrons are added to the ions compared to when they were atoms, the number by the - tells us how many electrons are added. Each added electron is a tab.

We don't write the number 1 in compounds.

Put brackets around a compound ion (that has more than one type of atom in it) if you need 2 or more of them to balance in a compound

Name of compound	magnesium	chloride
Formula of ions		
Number of each ion required to balance charges		
Formula of compound		

Name of compound	sodium	carbonate
Formula of ions		
Number of each ion required to balance charges		
Formula of compound		

Name of compound	copper nitrate
Formula of ions	
Number of each ion required to balance charges	
Formula of compound	

Name of compound	iron (II) hydroxide
Formula of ions	
Number of each ion required to balance charges	
Formula of compound	

Name of compound	lead oxide
Formula of ions	
Number of each ion required to balance charges	
Formula of compound	

Name of compound	silver nitrate
Formula of ions	
Number of each ion required to balance charges	
Formula of compound	

Name of compound	calcium carbonate
Formula of ions	
Number of each ion required to balance charges	
Formula of compound	

Name of compound	iron (III) nitrate
Formula of ions	
Number of each ion required to balance charges	
Formula of compound	

Name of compound	zinc oxide
Formula of ions	
Number of each ion required to balance charges	
Formula of compound	

Name of compound	lead chloride
Formula of ions	
Number of each ion required to balance charges	
Formula of compound	

Changing compound words into formulas – Visual balancing

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Cation			Anion
1+	2+	3+	1-
H Hydrogen	Fe Iron (II)	Al Aluminium	Cl Chloride
Ag Silver	Zn Zinc		OH Hydroxide
K Potassium	Pb Lead	Fe Iron (III)	NO₃ Nitrate
NH₄ Ammonium			HCO₃ Hydrogen Carbonate

Name of Compound	Positive ion (cation)	Negative ion (anion)	Formula of compound
Magnesium Chloride			
Lead oxide			
Sodium chloride			
Potassium chloride			
Copper sulfate			
Silver chloride			
Ammonium sulfate			
Calcium hydroxide			
Zinc nitrate			
Copper hydrogen carbonate			
Lead nitrate			
Iron (iii) hydroxide			
Potassium oxide			
Iron (ii) carbonate			
Ammonium carbonate			
Silver hydrogen carbonate			
Sodium carbonate			

Combination Reactions – Writing Word and Symbol Equations

Success Criteria: complete each level before moving onto the next

- Basic: write word equations for the following combination reactions
- Proficient: write symbol equations for the following combination reactions
- Advanced: balance the symbol equations for the following combination reactions

Remember: Combination reactions occur when two or more reactants combine for form one product

1. magnesium metal is burnt in oxygen gas.

Word equation _____

Symbol equation _____

2. sulfur is burnt in oxygen gas.

Word equation _____

Symbol equation _____

3. sulfur is heated with iron metal.

Word equation _____

Symbol equation _____

4. zinc metal is burnt in oxygen gas.

Word equation _____

Symbol equation _____

5. solid carbon is completely burnt in oxygen gas.

Word equation _____

Symbol equation _____

6. sodium metal is placed in a container with oxygen gas.

Word equation _____

Symbol equation _____

Thermal Decomposition Reactions – Writing Word and Symbol Equations

Success Criteria: complete each level before moving onto the next

- Basic: write word equations for the following thermal decomposition reactions
- Proficient: write symbol equations for the following thermal decomposition reactions
- Advanced: balance the symbol equations for the following thermal decomposition reactions

Remember: metal carbonate \rightarrow metal oxide + carbon dioxide gas

metal hydrogen carbonate \rightarrow metal carbonate + carbon dioxide gas + water

1. calcium carbonate powder is heated. Calcium carbonate is found in limestone rock and mollusc shells.

Word equation _____

Symbol equation _____

2. sodium hydrogen carbonate powder is heated.

Word equation _____

Symbol equation _____

3. copper carbonate powder is heated.

Word equation _____

Symbol equation _____

4. magnesium hydrogen carbonate powder is heated.

Word equation _____

Symbol equation _____

5. iron (II) carbonate powder is heated. Iron carbonate is an important iron ore.

Word equation _____

Symbol equation _____

6. potassium carbonate powder is heated. Potassium carbonate is used in the production of glass.

Word equation _____

Symbol equation _____

Displacement Reactions – Writing Word and Symbol Equations

Success Criteria: complete each level before moving onto the next

- Basic: write word equations for the following displacement reactions
- Proficient: write symbol equations for the following displacement reactions
- Advanced: balance the symbol equations for the following displacement reactions

Li	Na	Ca	Mg	Al	Zn	Fe	Pb	(H)	Cu	Ag	Au
----	----	----	----	----	----	----	----	-----	----	----	----

1. calcium metal and copper nitrate solution are mixed together.

Word equation _____

Symbol equation _____

2. magnesium metal and lead nitrate solution are mixed together.

Word equation _____

Symbol equation _____

3. zinc metal and iron (II) nitrate solution are mixed together.

Word equation _____

Symbol equation _____

4. magnesium metal and silver nitrate solution are mixed together.

Word equation _____

Symbol equation _____

5. calcium metal and zinc chloride solution are mixed together.

Word equation _____

Symbol equation _____

6. iron metal and copper sulfate solution are mixed together.

Word equation _____

Symbol equation _____

Precipitation Reactions – Using solubility rules to predict precipitates

Success Criteria: complete each level before moving onto the next

- Basic: beside each compound write S (soluble) or I (insoluble)
- Proficient: write the solubility rule used with exceptions
- Advanced: give the formula for each compound

Ion	Rule	Exceptions
nitrate	soluble	
chloride	soluble	silver and lead
sulfate	soluble	lead, calcium, barium
carbonate	insoluble	sodium
hydroxides	insoluble	sodium

compound	S or I	solubility rule used	formula of compound
lead sulfate			
sodium carbonate			
iron (II) nitrate			
magnesium hydroxide			
zinc chloride			
copper carbonate			
barium sulfate			
calcium chloride			
silver nitrate			
magnesium carbonate			
zinc nitrate			
sodium chloride			
Barium carbonate			
Iron (III) sulfate			

Precipitation Reactions – Writing Word and Symbol Equations

Success Criteria: complete each level before moving onto the next

- Basic: write word equations for the following precipitation reactions
- Proficient: write symbol equations for the following precipitation reactions
- Advanced: balance the symbol equations for the following precipitation reactions

Use your solubility rules to determine which product forms a precipitate and circle it.

1. sodium hydroxide solution and copper nitrate solution are mixed together.

Word equation _____

Symbol equation _____

2. magnesium sulfate solution and sodium hydroxide solution are mixed together.

Word equation _____

Symbol equation _____

3. sodium carbonate solution and silver nitrate solution are mixed together.

Word equation _____

Symbol equation _____

4. calcium chloride solution and sodium sulfate solution are mixed together.

Word equation _____

Symbol equation _____

5. lead nitrate solution and zinc chloride solution are mixed together.

Word equation _____

Symbol equation _____

6. iron(II) nitrate solution and sodium hydroxide solution are mixed together.

Word equation _____

Symbol equation _____

What reaction is that?

Success Criteria: complete each level before moving onto the next

- Basic: match reactants with reaction type
- Proficient: write the name of the product/products formed
- Advanced: write the formula of the product/products formed

Reaction types to select from are: displacement, precipitation, combination, thermal decomposition

1. sodium carbonate solution and copper nitrate solution are mixed together.

Reaction type: _____

Name of product/s _____

Formula of product/s _____

2. A piece of magnesium metal is added into copper nitrate solution.

Reaction type: _____

Name of product/s _____

Formula of product/s _____

3. copper carbonate powder is heated in a boiling tube over a Bunsen burner.

Reaction type: _____

Name of product/s _____

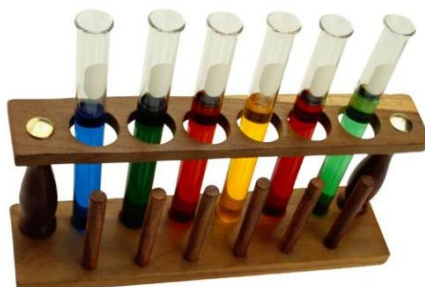
Formula of product/s _____

4. Iron metal fillings and solid sulfur are heated together.

Reaction type: _____

Name of product/s _____

Formula of product/s _____



Justifying your choice of reaction

Success Criteria: complete each level before moving onto the next

- Basic: label each reaction type
- Proficient: fill in the missing words for each justification of a reaction type
- Advanced: write an example with reactants and products for each reaction

Reaction types to select from are: displacement, precipitation, combination, thermal decomposition

1. Sodium carbonate is heated.

Reaction type: _____

Justification: these reactions occur when _____ substance is broken apart with the use of _____ energy into _____ or _____ smaller substances.

Example: _____

2. Magnesium metal is burnt in oxygen.

Reaction type: _____

Justification: these reactions occur when _____ reactants _____ to form _____ product.

Example: _____

3. silver nitrate solution is added to sodium chloride solution.

Reaction type: _____

Justification: these reactions occur when two _____ react together to form a _____ that settles out of the solution. The solid formed is called the _____.

Example: _____

4. zinc metal is placed in a solution of lead nitrate.

Reaction type: _____

Justification: these reactions occur when a _____ and salt (_____ compound) solution are mixed and the more _____ metal replaces the _____ in the salt.

Example: _____

Guidelines for Discussion

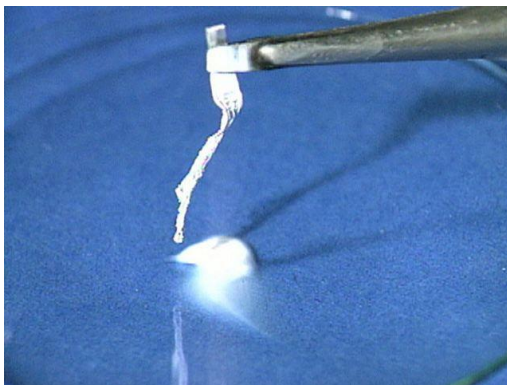
In your conclusion you must;

- Show Links between classification, products forms and observations plus equations
- Show Links between solubility rules and precipitates formed

Combination Reactions

Combination reactions occur when two or more reactants combine to form one product.

An example is a metal and oxygen forming a metal oxide or a metal and a non-metal reacting to form a ionic compound.



- ☐ General reaction description
- ☐ Write down observations: colour/ state of each reactant, the method you used and the colour/state of the product(s)
- ☐ Link your observations to the general reaction description to explain why you consider that to be evidence to be that type of reaction
- ☐ Include both word and formula (balanced with states) in your discussion

Precipitation Reactions

Precipitation reactions occur when two solutions react together to form a solid that settles out of the solution. The solid formed is called the precipitate.

An example is a lead (II) nitrate solution mixed with a potassium iodide solution to form a lead iodide precipitate.

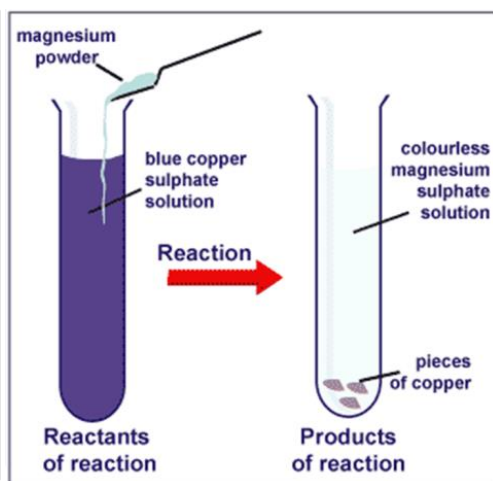


- ☐ General reaction description
- ☐ Write down observations: original colour of each solution and the final colour/state of the product.
- ☐ Link your observations to the general reaction description to explain why you consider that to be evidence to be that type of reaction – you must use your solubility rules to state why it is you believe the precipitate formed is the one you have written down and why the remaining ions are still in solution
- ☐ Include both word and formula (balanced with states) in your discussion
- ☐ Include both the full formula equation for both original solutions and then the ionic equation using just ions that form your precipitate. Don't forget ion charges and states

Displacement Reactions

Displacement reactions occur when a metal and salt (metal + non-metal ionic compound) solution are mixed and the metal replaces the metal in the salt.

An example would be reacting magnesium metal and copper sulfate to produce magnesium sulfate plus copper metal.

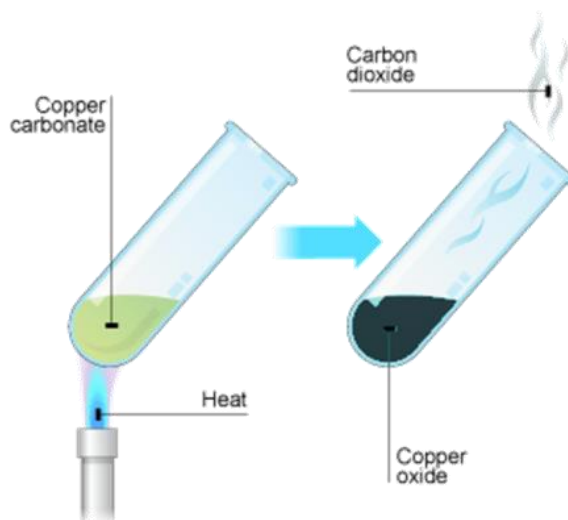


- ☐ General reaction description
- ☐ Write down observations: colour/ state of each reactant, the method you used and the colour/state of the product(s)
- ☐ Link your observations to the general reaction description to explain why you consider that to be evidence to be that type of reaction
- ☐ Discuss the reactivity of the metal added compared to the metal (in its ion form) in the solution and why the more reactive metal replaces the less reactive metal
- ☐ Include both word and formula (balanced with states) in your discussion

Thermal Decomposition Reactions

Thermal decomposition reactions occur when one substance is broken apart with the use of heat energy into smaller substances.

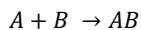
An example is copper carbonate heated which breaks down into carbon dioxide and copper oxide.



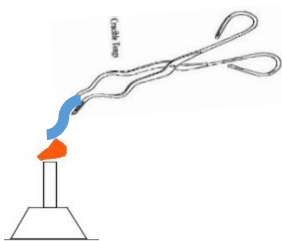
- ☐ General reaction description
- ☐ Write down observations: colour/ state of reactant, the method you used and the colour/state of the product(s)
- ☐ Discuss use of Limewater test to confirm the presence of Carbon dioxide gas
- ☐ Link your observations to the general reaction description to explain why you consider that to be evidence to be that type of reaction
- ☐ Include both word and formula (balanced with states) in your discussion

Combination reaction

Two elements or compounds combine to form one product



Example: Burn a strip of magnesium metal.



Word Equation:
magnesium + oxygen \rightarrow magnesium oxide

Observation:

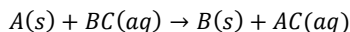
The shiny grey strip when burned in oxygen changed into a white solid substance called magnesium oxide. This is a combination reaction as *two substances combined to form one product*.

Balanced Symbol equation:

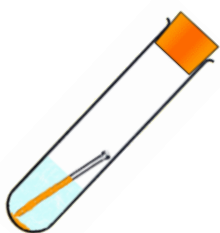


Displacement reaction

One element takes the place of another element in a reacting compound



Example: Place a zinc strip in lead nitrate solution

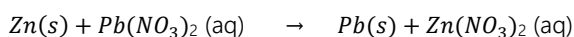


Word Equation:
Zinc + lead nitrate \rightarrow zinc nitrate + lead

Observation:

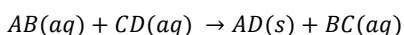
The shiny grey strip when placed in clear and colourless solution became covered in a grey solid substance called lead. The solution stayed clear and colourless. This is a displacement reaction as *a more reactive metal takes the place of another metal in a reacting compound*.

Balanced Symbol equation:



Precipitation reaction

Two elements in reactants take the place of each other and a solid forms in one of the products.



Example: Mix silver nitrate solution and sodium chloride solution



Word Equation:
Silver nitrate + sodium chloride \rightarrow silver chloride + sodium nitrate

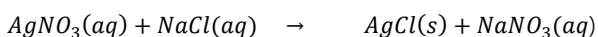
Solubility Rule:

All chlorides are soluble except silver chloride

Observation:

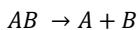
The two clear and colourless solutions were mixed to form a white precipitate called silver chloride. This is a precipitation reaction as *two elements in reactants take the place of each other and a solid forms in one of the products*.

Balanced Symbol equation:

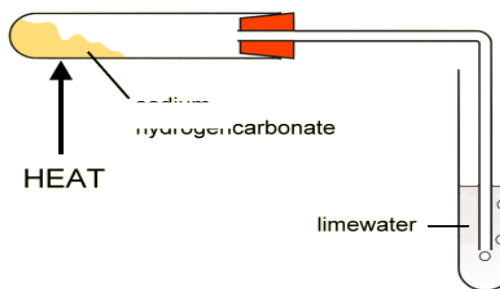


Decomposition reaction

One substance is split into two substances



Example: heat sodium carbonate powder

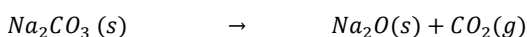


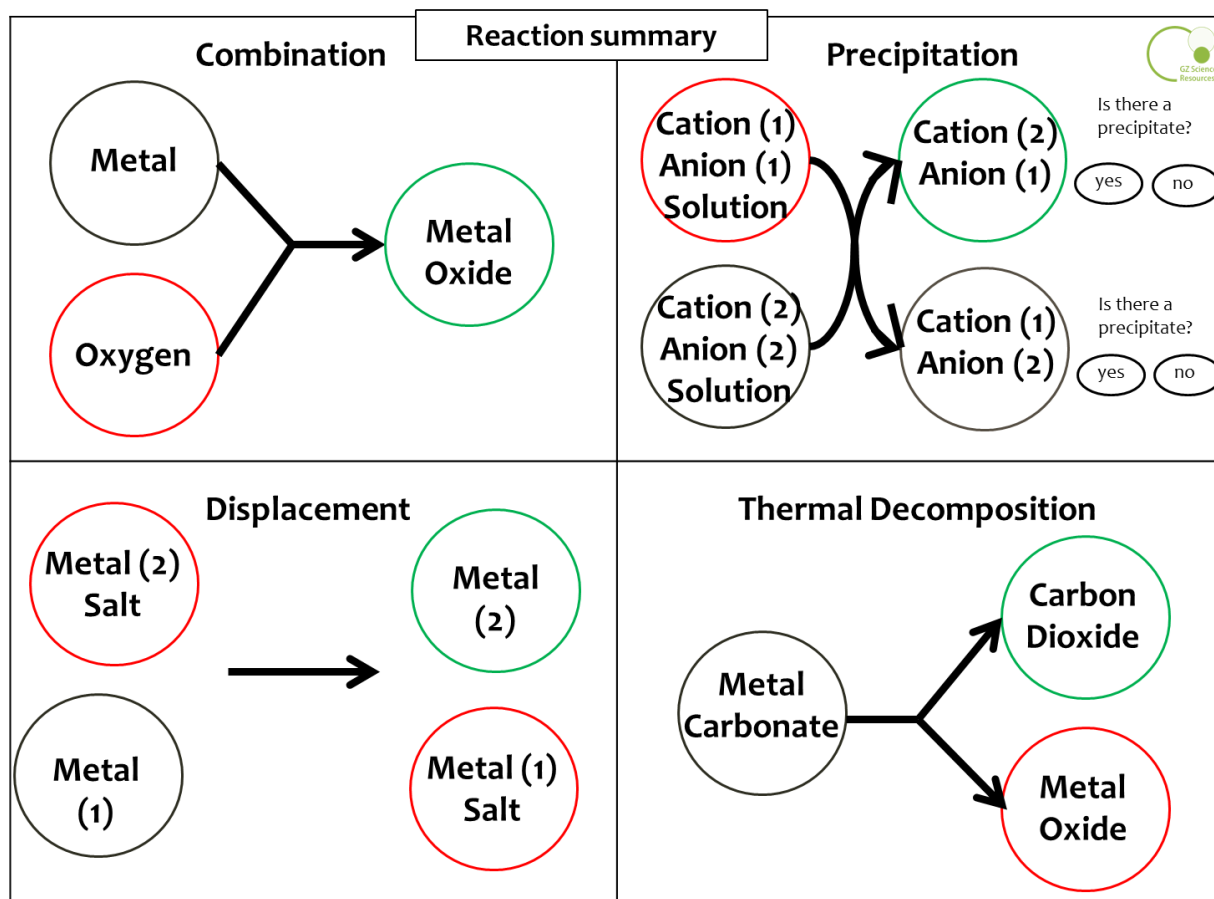
sodium carbonate \rightarrow sodium oxide + carbon dioxide

Observation:

The white solid when heated produced bubbles of colourless gas called carbon dioxide that when bubbled into the limewater, turned the limewater cloudy. Another white solid was formed and remained in the boiling tube. This is a decomposition reaction as *one substance is split into two substances*.

Balanced Symbol equation:





Observations

Observations must link the species (the reactant and the product it changes into) to the colour changes and/or appearance of gas.

Question: Mix sodium chloride solution and lead nitrate solution

When sodium chloride solution is mixed with lead nitrate solution the colourless solutions form a white precipitate

1. Identify the reactants from the question and write a word equation

sodium chloride + lead nitrate → lead chloride + sodium nitrate

2. Justify your reaction type based on reactants and products formed. If a precipitate is formed use the solubility rules to select which of the products is the precipitate.

all nitrates are soluble, all chlorides are soluble except silver and lead – so lead chloride is the precipitate

3. Write colours beside/underneath each reactant/product of each species – these will be collected from observation of the reaction (or memory/question)

sodium chloride (colourless solution) lead nitrate (colourless solution) lead chloride (white precipitate) sodium nitrate (colourless solution)

4. Write a comprehensive summary of this information

Sodium nitrate, a colourless solution⁻ is mixed with lead nitrate, a colourless solution and a white precipitate/solid is formed of lead chloride, because although most chlorides are soluble, lead chloride is an exception. The sodium nitrate formed remains as a colourless solution as the solubility rules state all nitrates are soluble. This is a precipitation reaction because the two solutions react together to form a solid that settles out of the solution. The solid formed is called the precipitate.